The relationship between the distribution and use patterns of parks and their spatial accessibility at the city level

The relationship between the distribution and use patterns of parks and their spatial accessibility at the city level: a case study from Tehran, Iran

Fariba Bahriny[1], Simon Bell[1] and Safora Mokhtarzadeh[2]

1. Estonian University of Life Sciences, Kreutzwaldi 56/3, 41014 Tartu, Estonia

2. University of Isfahan, Isfahan, Iran

Corresponding author email: faribabahrinyhu@gmail.com

ABSTRACT

Parks are recognised as important elements of urban green infrastructure and for providing many benefits to city residents. In countries where urban growth is unplanned and sprawling, green space provision falls behind, inadequate amounts are provided or spaces are not located in the most effective places. Tehran, the capital of Iran, has experienced huge growth in population and corresponding sprawl in recent years. There has been no study of the effectiveness of parks as part of the range of green spaces in the city – their location, accessibility within the urban structure, relationship to the socio-demographic character of the population, amount per capita or quality and condition. Using a combination of existing data supplemented by new data from site surveys, this study firstly looked at the citywide scale of public open space in relation to population and socio-economic patterns. Second, a representative sample of 16 parks was examined in terms of their accessibility within the urban street structure using space syntax. The syntactical results were correlated with several different aspects of each park collected and rated on a 1-5 scale. The results showed a wide range of availability of parks with no specific pattern related to whether the district is better off or poor. The data on green space per district was often heavily biased by the presence of large areas of forest park or non-recreational land which gives a false picture. Many of the best parks are poorly integrated into the street network and found in the better off districts yet are very popular because they are “destination” parks in cooler, hilly areas. Poorly integrated parks in the inner city districts tended to show lower levels of maintenance, were often little used and had vandalism. Much more attention is needed to provide green space in an equitable way.

KEYWORDS

Tehran, urban parks, green infrastructure, space syntax, spatial equity

INTRODUCTION

The value and importance of parks

Parks and urban green spaces have long been important for the quality of life in urban areas and are now accepted as vital parts of the urban green infrastructure, with important environmental, recreational, aesthetic, economic and health advantages (Chiesura, 2004; Mohsen, 2006; Gehl and Gemzoe, 2001; Peters, 2010; Rosenberger et al., 2009). They offer appealing views, can help to clean the air, to reduce noise, to control pollution and have positive microclimate effects (Escobedo et al., 2011; Groenewegen et al, 2006). They also increasingly playing a role in mental health (Hartig et al.,1991; Michie and De Rozarieux, 2001), physical health, health recovery and stress reduction (Rostami et al., 2015; Ulrich, 1983).

Urban green spaces also have a significant role in providing cultural ecosystem services and for supporting urban biodiversity (Crane and Kinzig, 2005). They are the main points of contact with the 'natural' environment for many (Jorgensen et al, 2002). The presence of parks and public space also increases potential for social interaction and community activities (Michie and De Rozarieux, 2001).

Urban development and green space: environmental equity

Over half of the global population lives in urban areas and this proportion is continually increasing (United Nations, 2005). While cities in western countries are often reasonably stable in population or are planned for controlled expansion, even here there is a tendency for sprawl to occur (Pauleit et al., 2010). Elsewhere is common to find an unplanned and uncontrolled or uncontrollable expansion taking place. This expansion is driven by a number of factors, especially the in-migration of people from rural areas or from other countries and it often results in poorer neighbourhoods becoming overcrowded (Bell et al, 2010). Poor housing, inadequate sanitation and high levels of crime are linked to a lack of green areas (Kuo and Sullivan, 2001). People living in such places also tend to be economically disadvantaged, with low-status jobs and generally poorer physical and mental health (Lindheim and Syme, 1983; Lavin et al., 2006; Ormel and Neeleman, 2000).

Several health benefits are associated with living near green space. In Swedish and Danish studies the chance of reporting good health was greater among people who used urban green spaces frequently than for non-users (Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007). Within cities, green space is often inequitably distributed and access can be highly stratified based on income, ethnicity, age, gender or disability (Byrne et al,, 2009).

The role of parks in Iranian cities

In countries with hot and arid climates, such as Iran, gardens have historically played a very important role within urban areas. There is a long tradition of parks and gardens being part of a city plan, with water playing a major role as a cooling element. Urban life for several centuries has included use of public and private gardens, making life bearable in the hot summer. Persian gardens achieved an intimate connection with city layout in the 11th century and became public places for citizens to stroll, meet and relax (Rostami et al., 2015; Moradi et al., 2012). Popular times to visit parks are in the evening and at night, when it is cooler and social activities are very common.

The fact that the Persian garden had become so efficient and effective for Iranian cities was ignored, as imitations of European gardens became fashionable (Rostami et al., 2015). According to recent research, Iranians do not tend to like such parks, preferring to visit natural settings; non-traditional Iranian urban parks often suffer from vandalism (Hami et al., 2011). However, urban residents still actively use historic Persian gardens.

Developing modern urban green spaces in Iran began in the 1950s when Bagh Melli[1], which was later renamed Shahr Park[2], was laid out in Tehran. It was not until the 1970s that building parks, gardens and villas like those in European countries came into vogue (Hekmati, 1994).

Green space in the city of Tehran

Tehran, the capital of Iran, covers some 700 km² with a population of almost 12 million in the city and surrounding province. While being Iran's administrative, economic, and cultural centre Tehran exhibits many social and environmental problems (Madanipour, 1999). As the city has expanded, the provision of facilities and greenspaces has not been able to keep pace. Over the past three decades, immigration has led to the development of large squatter settlements in the urban fringe (Azimi, 2004), containing more than 40% of Tehran's population. These have many social, environmental and economic problems (Andalib, 2007). Recent developments of public green space and parks have been unable to re-establish an ecological network fragmented by uncontrolled and unplanned growth (Bahrami and Aiyanna, 2012).

The Department of Environment of the UN recommends 20-25 m^2 green space per capita (Tavahon, 2004). The official target green space per capita in Iran is only 7-12 m^2 (Asgari, 2002,). Even though there is evidence that the ratio of green space per capita may be up to 17 m^2, this includes all the city green spaces, many of which are not parks or publicly accessible areas.

[1] Literally "National Park"

[2] Literally "City Park"

Another problem in Tehran is the uneven distribution of green space. In some parts it is less than the urban standard and in others it is more. Districts of the city differ in climatic and physical conditions such as slope, elevation and water availability. Jalili and Khosravi (2007) noted that while the Tehran master plan proposes to increase green space per capita, it does not address the gap between different districts. Figure 1 shows a map of Tehran with its topography, watercourses, main roads and all parks and incidental green spaces.

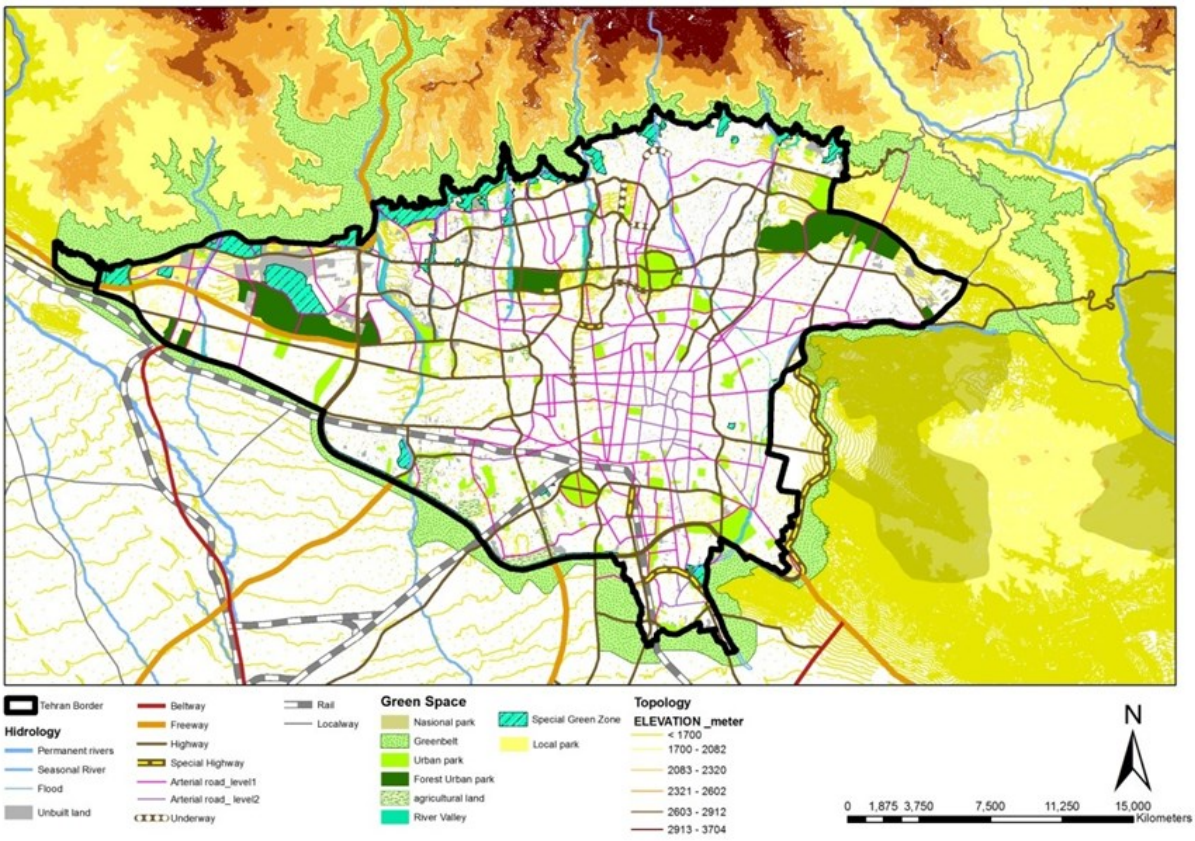

Figure 1: Map showing the context of Tehran in its topographical setting, main street pattern and all green spaces of various different categories (author's illustration, based on data from Tehran municipality)

As well as the amount and distribution of parks and green spaces, accessibility and quality are also important factors. In order to help improve the quality of life of its citizens more focus should be given to the development of the park and green space system for Tehran and for this more analysis of the existing situation is needed, especially concerning the distribution, accessibility and use patterns of its existing parks.

Research objective and questions

The objective of the research was to examine the distribution of green spaces in general and parks in particular, at the scale of the entire city, in terms of their accessibility, the demographic character of their catchment and their current usage. The specific research questions were:

1) How are the green spaces and parks distributed in relation to the urban structure and how does this affect their accessibility?

2) Is there a relationship between the degree of accessibility of parks, their quality and level of use?

3) How equitably are the parks distributed in relation to the socio-economic and demographic structure of the city?

METHODS

Research strategy

We selected the Tehran Metropolitan Area as the study unit and firstly we analysed the amount of green space per capita at city district level in order to get an idea of how much there is according to population densities and socio-economic levels.

As the task of evaluating every park in the city was outside the scope of available resources, we decided to examine a sample of 16 officially designated “city parks” representative of almost every city district (some districts have no city parks at all). Then, in order to test their accessibility, we tested their degree of integration into the street structure using Space Syntax (Hillier et al., 1993). We also assessed each park on site for their level of use, range of activities, quality of maintenance, evidence of anti-social activities and the demographic character of their catchment, which we correlated with the degree of syntactical integration. We took the statistically significant correlations and looked for explanations of the patterns they revealed.

City-level assessment of green spaces

We took the population data and socio-economic status for each city district and the map layer of all green areas including parks of all kinds and other green areas (a mixed category including agricultural land, green strips along roads and open unbuilt land with no specific uses). Using ArcGIS 9.3 we took the population in each district and its density and calculated the amount of green space per inhabitant. This gave us a picture of the overall pattern and distribution of green areas as well as an indication of the degree of environmental equity.

Selection of sample parks

To select the sample parks, we consulted the most recent (2007) Master Plan for the city of Tehran (Municipality of Tehran). We excluded the incidental green spaces, focusing on the official "city parks".

The "Typology (Clustering) of Neighbourhoods in Tehran" (Department of Social and Cultural Studies of Tehran Municipality, 2011) divided the city into socio-economic clusters based on three variables: economy, literacy, and proportion of the immigrant population living there. Neighbourhoods with similar conditions were grouped into ten classes and we selected the sample parks to ensure that they were well-distributed across all socio-economic clusters. The numbering system for the clusters is based on the socio-economic status: the higher the number, the higher the socio-economic status.

Table 1 Shows the total of all parks and green spaces by socio-economic cluster together with their cumulative area, total population and amount of green space per capita. Table 2 lists the sample of parks in each socio-economic cluster and Figure 2 shows their location on the socio-economic map of the city.

Table 1. The total of all parks and green spaces by socio-economic cluster together with their cumulative area, total population and green space amount per capita (based on data from Tehran municipality).

Parks	***Cluster***	***Area (km^2)***	***Total green space area***	***Total population per cluster***	***Total green space amount per capita***
Laleh	*10*	*21.2*	*2.64*	*229,980*	*11.5*
Abo Atash	*10*	*31.3*	*4.49*	*314,112*	*14.3*
Mellat	*9*	*31.3*	*4.49*	*314,112*	*14.3*
Jamshidiyeh	*9*	*64*	*7.33*	*439,467*	*16.7*
BaghHonar	*8*	*21.2*	*2.64*	*229,980*	*11.5*
Shahed	*8*	*54.7*	*13.01*	*793,750*	*16.4*
Daneshjoo	*7*	*21.2*	*2.64*	*229,980*	*11.5*
Bahmaninejad	*7*	*54.7*	*13.01*	*793,750*	*16.4*

Esteghlal	*6*	*51.6*	*3.09*	*162,681*	*19*
Shahr	*5*	*16.9*	*1.17*	*240,720*	*4.9*
Razi	*5*	*12.6*	*1.32*	*288,884*	*4.6*
Eram	*4*	*54.7*	*13.01*	*793,750*	*16.4*
Shabnam	*3*	*54.7*	*13.01*	*793,750*	*16.4*
Besat	*2*	*16.51*	*2.67*	*287,803*	*9.3*
Azadegan	*2*	*35.43*	*7.79*	*638,740*	*12.2*
SardarJangal	*1*	*16.51*	*2.67*	*287,803*	*9.3*
Bahman	*1*	*16.51*	*2.67*	*287,803*	*9.3*

Table 2: The sample of parks selected for the research by socio-economic cluster with their area and main characteristics (based on data from Tehran municipality)

Park name	**Socio-economic cluster**	**Total area (m^2)**	**Parks Characteristics**
Laleh	10	280000	A destination park with different and flexible areas for many activities
Abo Atash	10	65000	A destination park with many recreational and commercial elements
Mellat	9	340000	A destination park with a lake and many recreational facilities
Jamshidiyeh	9	69000	A destination park with lake, restaurant and open-air amphitheatre
BaghHonar	8	59140	A destination park with many facilities and also hosting the Iranian Artist s forum.
Shahed	8	31600	A local park with areas for ball games and children play
Daneshjoo	7	32500	A destination park with a city theatre
Bahmaninejad	7	31674	A local park withball games and children's play
Esteghlal	6	13500	A local park with children playground
Shahr	5	250000	A destination park with a lake, library and peace museum
Razi	5	257900	A local park with lakes, a skate park, areas for ball games andchildren's recreational centre
Eram	4	700000	A destination park with different areas for a variety of activities and attractions
Shabnam	3	8310	A local park with children play
Besat	2	530000	A destination park with amusements and commercial activities

Azadegan	2	1120000	A destination park with flexible areas for different activities, a lake, ball game areas; popular with Afghan immigrants
SardarJangal	1	13500	A local park with playground and women-only exercise area,
Bahman	1	150539	A local park with children's play and football

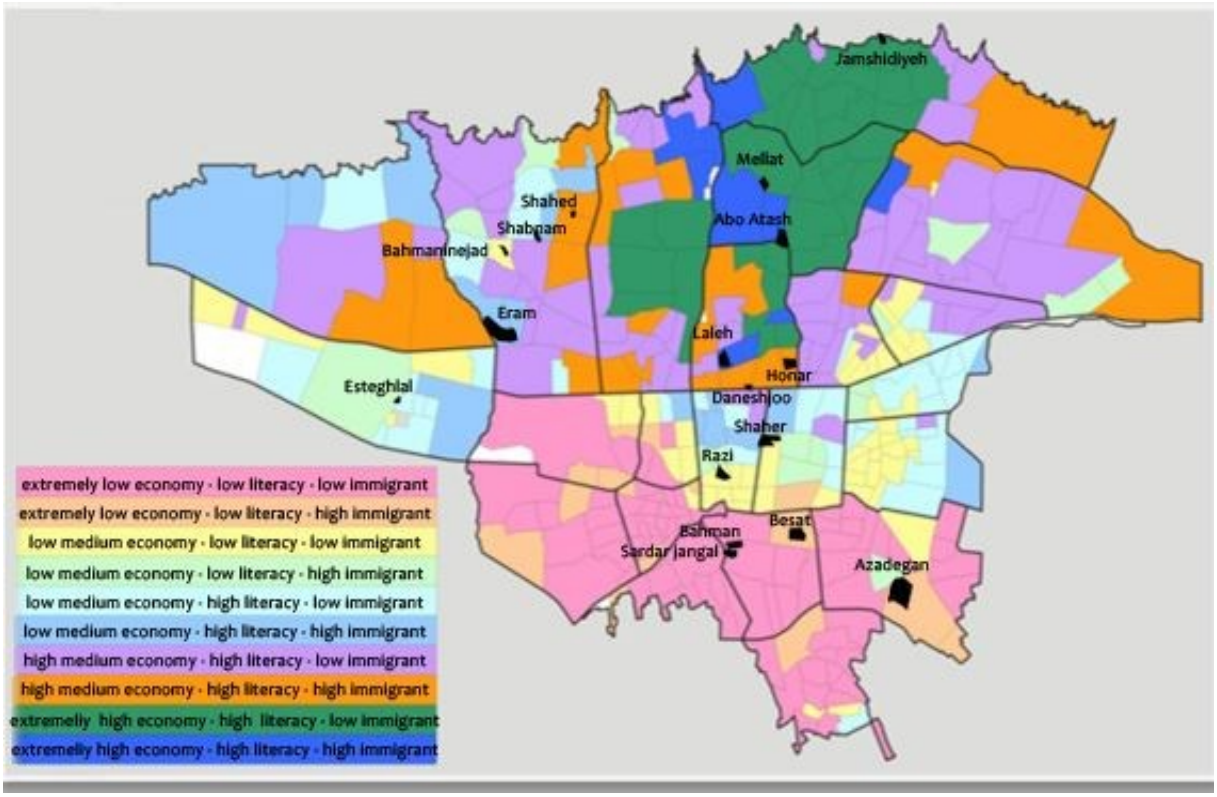

Figure 2: The location of the sampled parks on the socio-economic cluster map of Tehran. (author's illustration, based on data from the "typology (clustering) of neighbourhoods in Tehran" in 2011, social and cultural studies of Tehran Municipality)

Calculating the catchment population of each sampled park

We placed 500m, 100m and 1500m buffers around each park and estimated the population residing within each increasing zone based on the relative proportion of the population of the district, using the most recent census data (Statistical Centre of Iran, 2011). This enabled us to evaluate the potential usage of the park and to compare this with the on-site assessments (see below). Table 3 shows the population of the catchment of each park to the three radii and Figure 3 shows the buffer zones for each park to each radius. There is overlap in several cases where the population at 1000 or, especially, 1500 metres distance have access to more than one park but many have their own discrete catchment.

Table 3: The population of the catchment of each park to the three radii buffering around each sample park (based on data from theTehran Master Plan, Tehran GIS Centre, 2007)

Parks	***Pop(500m)***	***Pop(1000m)***	***Pop(1500m)***
Melat	73447	383734	425838
Lale	24075	71974	145525
Shahr	20033	66392	147264
Shabnam	30123	87713	170087
Shahed	18012	61525	138882
Razi	43348	138405	271135
Daneshjoo	9012	40052	88184
Jamshidiye	788	5914	19862
Bahmaninejad	12682	64638	144414
Besat	25379	78106	183871
Honar	10097	48837	114297
Azadegan	14376	79362	222663
Abo atash	7602	30672	69710
Esteghlal	14501	50526	85647
Eram	23778	67199	136607
SardarJangal	21873	71226	163118

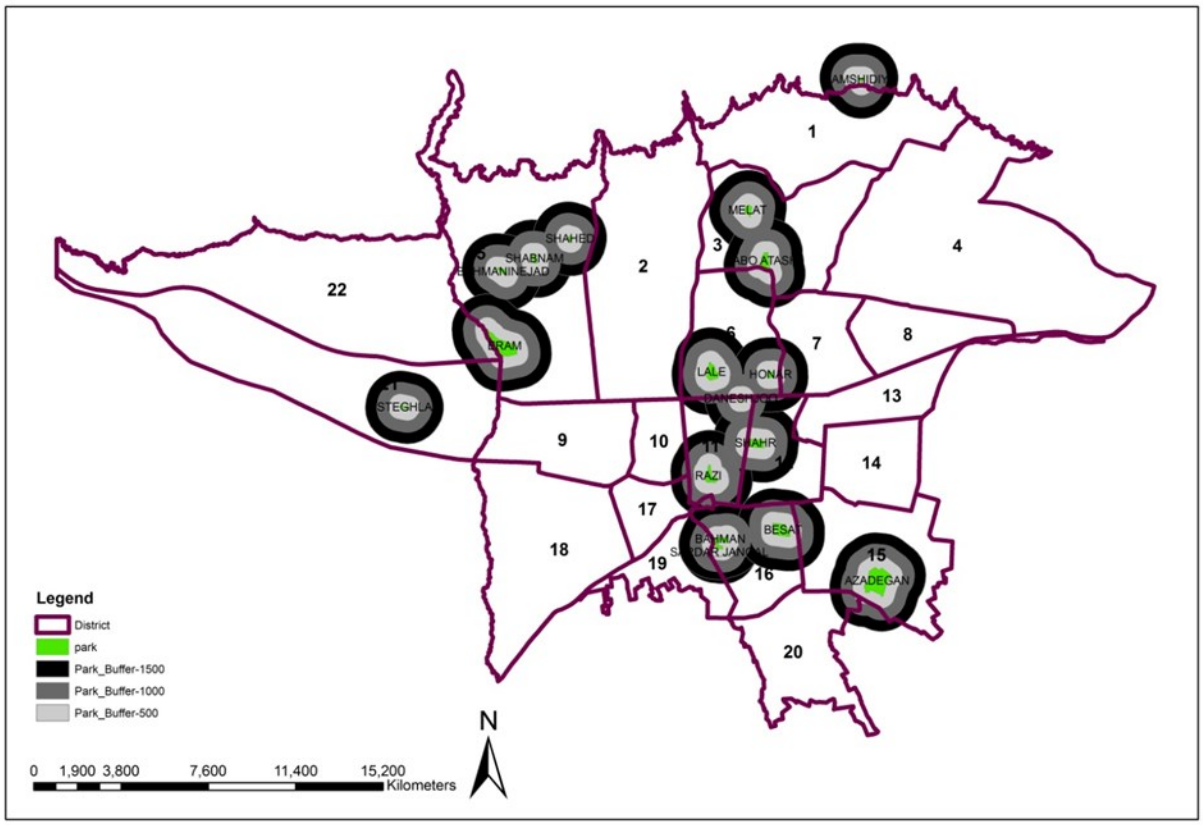

Figure 3: Map showing the buffers around each sample park. (author's illustration, based on data from Tehran Master Plan, Tehran GIS Centre, 2007)

Space syntax analysis of the sample parks

We studied the 16 selected parks in relation to their street accessibility at the city level. For this we used Space Syntax to test the degree to which they were or were not located by chance in places with a high degree of accessibility. Hillier (1993) developed the space syntax approach for analysing street structure according to his Natural Movement Theory. This states that the urban space configuration dictates the formation of social and behavioural patterns such as the movement of people within a street system. This theory claims that the relationship between the elements constructing a city plays a more important role than that of each individual element (Hillier et al., 1993). Since parks are one form of attraction, they could in theory be located to take advantage of the configuration in order to attract users, or it could be that those which by chance are found in locations with strong movement patterns tend to be more popular than those which are not. The hypothesis used here is that parks lying in highly integrated areas should be more attractive to users and more accessible from the surrounding street system.

Integration is the main space syntactical concept of spatial arrangement. It defines the value of integration of a line or space as the average number of intermediate lines (or spaces) through which all spaces are accessible. There are three degrees or radii of integration: global (the entire city in this case), referred to as Rn, local, where a more limited analysis is conducted, referred to as R3 and radius-radius integration (the relationship between Rn and R3) referred to as Rr. For further details of space syntax theory and application see Hillier et al. (1993). In general, the theory states that the greater the degree of integration at all radii the more attractive that particular city street segment will be.

In order to understand the Tehran urban structure, we produced an axial line map for the city using Depthmap software (Turner, 2004) and investigated integration at the three radii: Rn, R3, and Rr.

Site assessment of the sample parks

We visited each park to assess its physical condition, to record the activities taking place and the estimated numbers and types of users. The survey took place during the period from early to late evening, which is the most common and popular time to visit parks in Tehran, after work and when it is cooler. We assessed each park using the following criteria: accessibility to and within the park (very easy to very difficult); the level of management and maintenance (very well to very poor); the number of users and range of activities being pursued (very busy to very quiet) and evidence of anti-social behaviour (very little to very much). The criteria were based on those of Golkar (1998). We rated each criterion on a scale of 1-5 where 1 was the lowest value and 5 was the highest value.

Data processing and analysis

A number of tables were assembled using combinations of secondary data in order to present the results of the analyses of the city-level evaluation of green spaces in relation to the socio-economic status, population density and amount of green space per inhabitant.

The space syntax integration scores for each park were calculated for each radius (Rn, R3 and Rr) and entered into an Excel spreadsheet. Syntactic maps, colour-coded for the degree of integration, were also produced. The rating scores from the assessment of the parks were also entered into the spreadsheet. In order to test the relationships a series of correlations was carried out. Owing to the low sample size and presence of ranked data (because of the scoring method used in the data collection) we used the Spearman correlation.

RESULTS

Distribution of green space in city districts of Tehran

Table 4 shows the distribution of the total green space, population, population density and amount of green area per capita in each district, together with some notes about the character of the green spaces. District 19 consists of 61.3% green space making it the greenest in the city. District 22 with 33.6% is the second greenest and District 21 with 19% is the third greenest. The central Districts such as 7,8,10 and 11 have the lowest proportions of green space.

Table 4: The distribution of the amount of total green space, population, population density and amount of green area per capita in each district, with some notes about the character of the green spaces. (based on data from Tehran municipality followed by GIS analysis).

District	Total green space of all kinds (%)	Total population	Population density/km	Green space per capita	Proportion of green space by type (%)	
1	7.33	439,467	69	16.7	Parks River valley Open spaces	10 12 78
2	11.20	632,917	99	17.7	Parks Forest parks Garden and fields River valley Open space	3 31 8 29 29
3	4.49	314,112	100	14.3	City parks Forest parks River valley Open spaces	43 11 20 25
4	6.80	861,280	140	7.9	Parks Forest parks Garden and fields River valley Open space	16 74 1 5 4
5	13.01	793,750	145	16.4	Parks Garden and fields River valley Open space	23 1 11 65
6	2.64	229,980	108	11.5	Parks Open space	77 23

7	1.14	309,745	201	3.7	Parks River valley	95 5
8	1.55	378,118	286	4.1	River valley	100
9	0.82	158,516	80	5.2	Parks River valley	26 74
10	0.54	302,852	371	1.8	Parks	100
11	1.32	288,884	229	4.6	Parks Open space	97 3
12	1.17	240,720	142	4.9	Parks	100
13	2.09	276,027	215	7.6	Parks Forest parks River valley	77 15 8
14	2.42	484,333	220	5	Parks Garden and fields River valley Open space	61 3 25 11
15	7.79	638,740	180	12.2	Parks River valley	94 6
16	2.67	287,803	174	9.3	Parks Open space	97 3
17	2.95	248,589	302	11.9	Parks Open space	49 51
18	4.65	391,368	103	11.9	Parks Garden and fields River valley Open space	37 42 4 17
19	14.97	244,350	119	61.3	Parks Garden and fields Open space	94 1 5
20	5.38	340,861	142	15.8	Parks Garden and fields Open space	73 5 22
21	3.09	162,681	32	19	Parks Forest parks River valley Open space,	60 26 13 1
22	4.33	128,958	21	33.6	Parks Forest parks River valley Open space	3 37 8 53

Central districts with the smallest territory are generally the most densely populated. However, District 4, with more than 861 people per hectare (in the built up areas, not counting the large forest park on its northern edge), is the most densely populated district of Tehran, while District 5 with 793 people per hectare is the second most. The

population density generally lessens gradually towards the outer areas such as District 21.

Comparing the amount of green space per capita across city districts with the suggested standard for the Iranian cities of between 7 and 12 m^2, we found that few districts meet the standard. Table 4 shows that the amounts of green space per capita vary considerably. Central districts of the city contain the lowest proportion of green space while being the most densely populated.

Looking in more detail, we can see that District 21, in the western most part of the city, with 19% green space is the third greenest but has only 1.9% of the city's total population at a density of 32 people per km^2. District 22, the second greenest area in the city, mainly comprises industrial areas with limited residential land but also hosts a botanic garden and a large nature park. District 4 contains 10.3% of the city's total population in very dense streets but these are next to a large forest park and also a national park lying on the edge of the city.

Looking more closely at the relationship of the amounts of green space with the socio-economic classification, it becomes clear that while some of the poorer areas have a lot of green space in total this is often not public park but non-recreational land use. Conversely, while the richer areas may have less green space in total, they are endowed with more parks, especially some of the larger destination parks located up in the hills to the north. District 2 has a large forest park but this is surrounded by expressways and not very accessible to the residents of nearby dense housing areas.

Integration of the sample parks from the space syntax

Figures 4 to 6 show the locations of the parks in relation to the axial maps for each level of integration. As expected, some parks are more integrated into the street network than others. However, this integration is most significant at the Rn or global level. Figure 4 shows that quite a large section of the centre of Tehran is strongly integrated at the global level (red and orange areas) and it can be seen how several parks lie well within this zone. Thus they should be accessible from a wide section of the city as a whole. Conversely, the least integrated areas (turquoise and blue) lie in the periphery and particularly in the north. Here the street layout is constrained by slopes, leading to much less cross-connectivity. Several parks are located in this area, suggesting that they are not so easily accessible. Likewise, in the south and parts of the west of the city, global integration is also low. Table 5 presents the integration indices at Rn for all parks, in descending order.

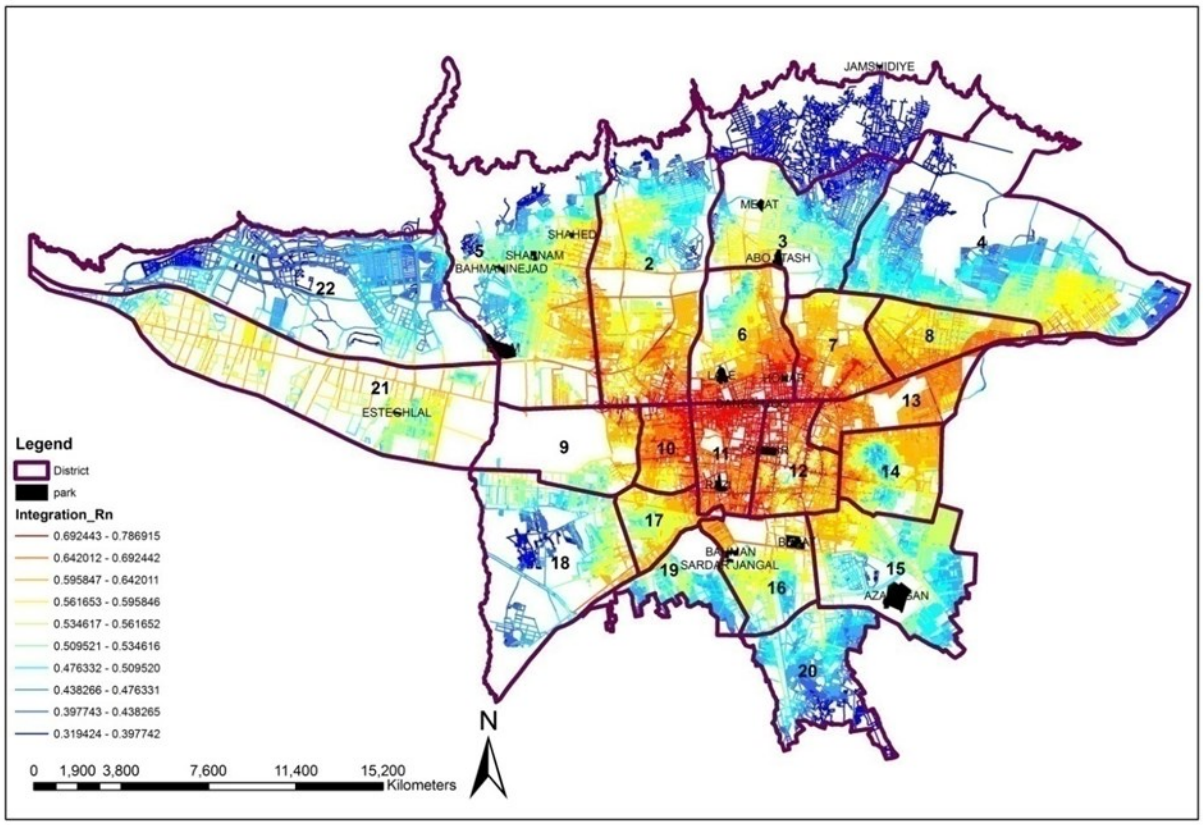

Figure 4: The distribution pattern of Rn integration in the selected parks in Tehran axial-line map. (author's illustration, based on data from Tehran Master Plan, Tehran GIS Centre, 2007)

Table 5: The location of the selected parks in socioeconomic clusters with integration Rn (based on data from the Department of Social and Cultural Studies of Tehran Municipality andTehran Master Plan, Tehran GIS Centre, 2007)

Park	Cluster No	Integration Rn
Abo Atash	10	0.58
Laleh	10	0.66
Jamshidiyeh	9	0.33
Mellat	9	0.55
Shahed	8	0.59
BaghHonar	8	0.72
Daneshjoo	7	0.77
Bahmaninejad	7	0.53
Esteghlal	6	0.57
Shahr	5	0.74
Razi	5	0.72
Eram	4	0.56
Shabnam	3	0.51

Azadegan	2	0.52
Besat	2	0.65
SardarJangal	1	0.57
Bahman	1	0.6

According to the results, Daneshjoo, Shahr, Razi and Bagh Honar are the most highly globally (Rn) integrated parks, while Jamshidiyeh, Shabnam and Azadegan are the least integrated. Some of these are in the highest and some in the lowest socio-economic clusters.

Looking at local integration (R3) we can see that the pattern is very different (Figure 5): the highly integrated areas appear as isolated patches across the city, often separated by locally non-integrated areas. When the relationship of the sample parks to the pattern is examined it can be seen that some parks which were highly integrated in the global picture are also integrated in the local picture (Daneshjoo and Shahr) while others emerge as being more highly integrated, such as Sardar Jangal. Jamshidiyeh, conversely, remains in the non-integrated areas while others drop to the bottom of the integration scale such as Abo Atash and Eram. Thus, some parks emerge as being locally accessible which were not so at the global level. Table 6 presents the integration indices at R3 for all parks, in descending order.

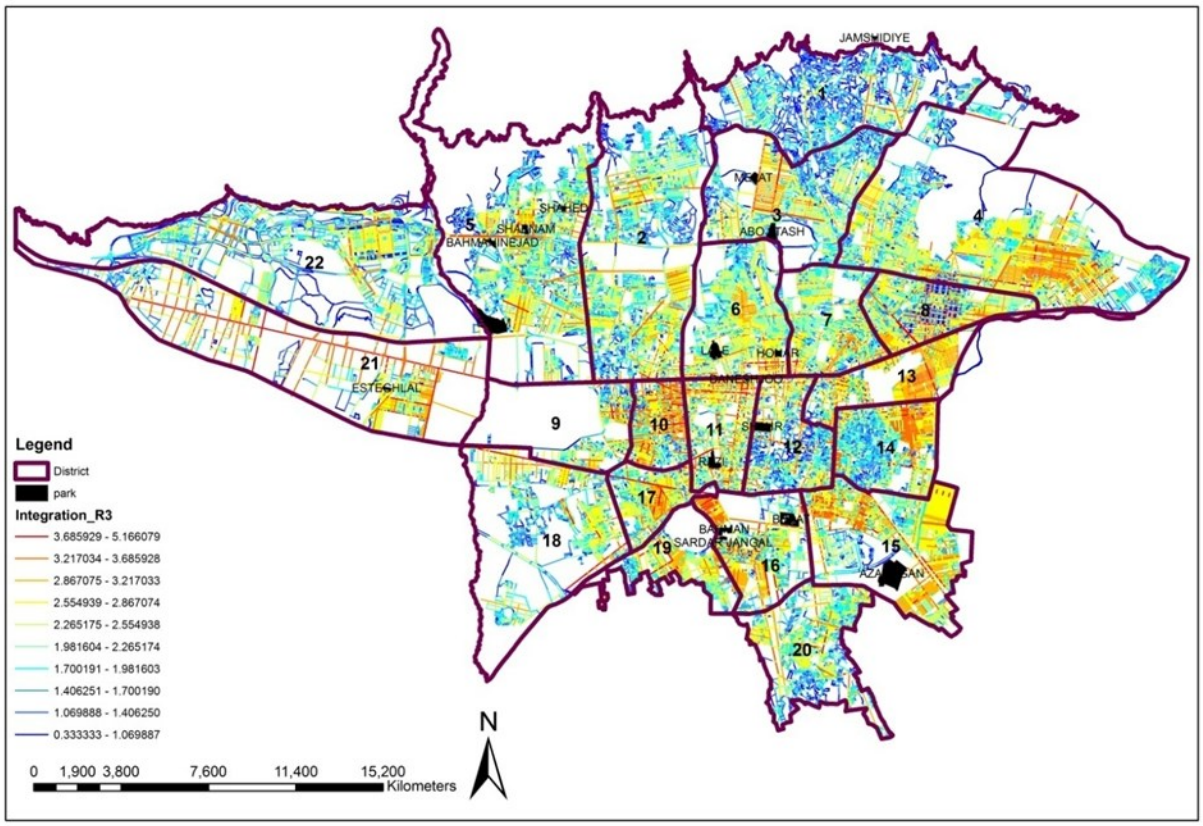

Figure 5: The distribution pattern of R3 local integration in the selected parks in Tehran axial-line map (author's illustration, based on data from Tehran Master Plan, Tehran GIS Centre, 2007)

Table 6: The location of the selected parks in socioeconomic clusters with local integration R3 (based on data from Social and Cultural Studies of Tehran Municipality and Tehran Master Plan, Tehran GIS Centre,2007)

Park	Cluster No	Integration R3
Abo Atash	10	2.07
Laleh	10	2.88
Jamshidiyeh	9	1.83
Mellat	9	2.8
Shahed	8	2.97
BaghHonar	8	2.64
Daneshjoo	7	3.77
Bahmaninejad	7	2.42
Esteghlal	6	3.03
Shahr	5	3.76
Razi	5	3.42
Eram	4	2.13
Shabnam	3	2.37
Azadegan	2	2.67
Besat	2	2.64
SardarJangal	1	3.52
Bahman	1	2.8

The radius-radius integration shows the relationship of the global to the local patterns: the higher scores show areas that are integrated at both Rn and R3, while the lowest scores show a low degree of integration at both levels as shown in Figure 6. Thus, parks within highly integrated Rn areas ought to be the most accessible of all and ought to demonstrate popularity among the users. Azadegan, Daneshjoo and Razi, respectively, are the top parks in terms of Rr index. Jamshidiyeh, Eram and Abo Atash, respectively, maintain the minimum values. Table 7 presents the integration indices at Rr for all parks, in descending order.

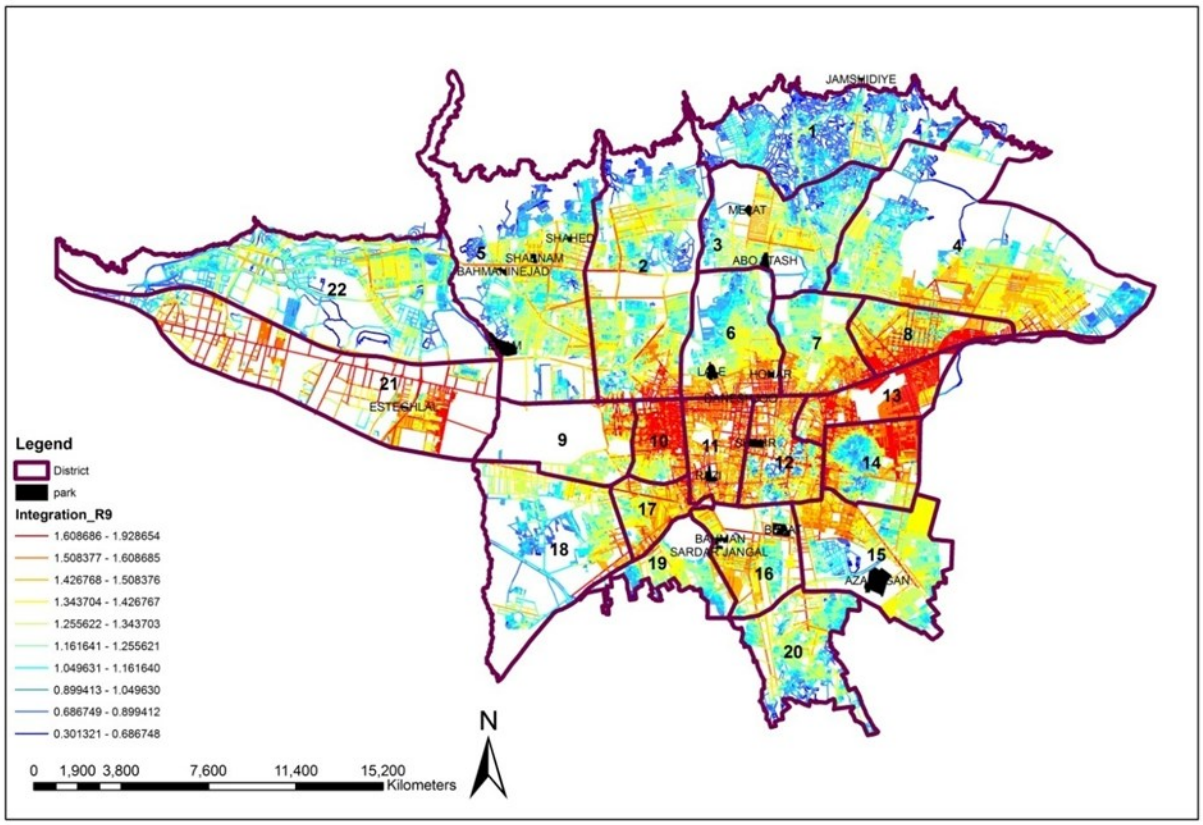

Figure 6: The distribution pattern of Rr integration in the selected parks in the Tehran axial-line map (author's illustration, based on data from Tehran Master Plan, Tehran GIS Centre, 2007)

Table 7: The location of the selected parks in socioeconomic clusters with integration Rr (based on data from Social and Cultural Studies of Tehran Municipality 2013 and Tehran Master Plan, Tehran GIS Centre, 2007)

Park	Cluster No	Integration Rr
Abo Atash	10	1.27
Laleh	10	*1.41*
Jamshidiyeh	9	1.08
Mellat	9	1.42
Shahed	8	1.42
BaghHonar	8	1.54
Daneshjoo	7	1.76
Bahmaninejad	7	1.38
Esteghlal	6	1.59
Shahr	5	1.7
Razi	5	1.73

Eram	4	1.2
Shabnam	3	1.37
Azadegan	2	3.85
Besat	2	1.51
SardarJangal	1	1.54
Bahman	1	1.42

Site assessment of the sampled parks and their relationship to other factors

Table 8 shows the scores for each sampled park according to the site assessment criteria, together with the socio-economic level, population within 500, 1000 and 1500 m of each park and the three degrees of integration. Correlations were calculated between each variable and with the integration values. Only those correlations which proved to be significant are presented below.

Table 8: The scores for each sampled park according to the criteria used in the site assessment, together with the socioeconomic level, population within 500, 1000 and 1500 m of each park and the degree of integration Rn, R3 and Rr. (based on data from, theTehran Master Plan, Tehran GIS Centre,2007). Abbreviations: ***Pop:*** *population,* ***Area*** *(Ha),* ***PD****: population density per km²*

Parks	Pop 500 m	Area 500 m	PD 500 m	Pop 1000 m	Area 1000m	PD 1000 m	Pop 1500 m	Area1500 m	PD 1500 m	Integration Rn	Integration R3	Integration Rr	Size (m^2)	Socio-economic	level of use	Activity	Accessibility	Anti-social	Green space per capita	Population 2011	Green area(km^2)
Melat	73447	159	461	383734	464	826	425838	927	460	0.55	2.8	1.42	340,000	10	5	5	4	1	14.3	314,112	4.49
Lale	24075	217	111	71974	562	128	145525	1063	137	0.66	2.88	1.41	280,000	8	4	5	5	2	11.5	229,980	2.64
Shahr	20033	210	95	66392	552	120	147264	1052	140	0.74	3.76	1.7	250,000	4	2	3	4	3	4.9	240,720	1.17
Shabnam	30123	146	206	87713	441	199	170087	893	191	0.51	2.97	1.37	8,310	7	2	1	3	2	16.4	793,750	13.01
Shahed	18012	118	153	61525	389	158	138882	818	170	0.59	2.97	1.42	31,600	7	5	4	4	1	16.4	793,750	13.01
Razi	43348	217	200	138405	563	246	271135	1065	255	0.72	3.42	1.73	257,900	5	3	3	2	3	4.6	288,884	1.32
Daneshjoo	9012	108	83	40052	372	108	88184	792	111	0.77	3.77	1.76	32,500	5	4	3	5	4	11.5	229,980	2.64
Jamshidiye	788	140	6	5914	432	14	19862	881	23	0.33	1.83	1.08	69,000	9	4	3	3	1	16.7	439,467	7.33
Bahmaninejad	12682	153	83	64638	455	142	144414	913	158	0.53	2.42	1.38	31,674	7	2	3	3	2	16.4	793,750	13.01
Besat	25379	237	107	78106	594	131	183871	1109	166	0.65	2.64	1.51	530,000	1	3	4	3	3	9.3	287,803	2.67
Honar	10097	136	74	48837	422	116	114297	866	132	0.72	2.64	1.54	59,140	8	5	4	5	1	11.5	229,980	2.64
Azadegan	14376	375	38	79362	809	98	222663	1398	159	0.52	2.67	3.85	1,120,000	6	3	3	2	3	12.2	638,740	7.79
Abo atash	7602	226	34	30672	582	53	69710	1095	64	0.58	2.07	1.27	65,000	10	5	5	3	1	14.3	314,112	4.49
Esteghlal	14501	131	111	50526	414	122	85647	854	100	0.57	3.03	1.59	13,500	7	1	1	2	3	19	162,681	3.09
Eram	23778	348	68	67199	784	86	136607	1377	99	0.56	2.13	1.2	700,000	6	3	5	3	2	16.4	793,750	13.01
SardarJangal	21873	127	172	71226	407	175	163118	844	193	0.57	3.52	1.54	13,500	2	2	2	3	2	9.3	287,803	2.67

Relationship of integration with accessibility and socio-economic status

There was a significant positive correlation between accessibility (rs=0.,582 N=16, p<0.0005, two-tailed) (p=0.018) and integration Rn. The fact that it is the Rn global integration that was correlated and not the R3 local or Rr radius-radius integrations could be inferred from the analysis of the syntactic patterns.

There is a significant negative correlation between the socio-economic level of the district (rs=-0.536, N=16, p<0.0005, two-tailed) (p=0.032) and integration R3 and (rs=-0.553, N=16, p<0.0005, two-tailed) (p=0.026) with integration Rr. This suggests that the more integrated areas within the city at the local scale are those with lower socio-economic status. An examination of the maps in Figures 1 and 2 shows that the areas with highest socio-economic status tend to be in the north of the city where the topography is steep and street density is lower and less connected. The parks here are also less integrated for the same reasons, as noted in section 3.1.

Relationship of park size, level of activity, management/maintenance and signs of anti-social behaviour

There was a statistically significant positive correlation between park size (rs=-0.606, N=16, p<0.0005, two-tailed) (p=0.013) and level of activity observed there. This may seem like an obvious conclusion but it depends on the larger parks being more developed, which is not always the case. The larger parks are not always in accessible areas – there was no significant relationship between size and integration – or in areas with the densest population

The socio-economic level of the areas where the parks are located was significantly negatively correlated (rs=-0.761, N=16, p<0.0005, two-tailed) (p=0.001) with signs of anti-social activity and significantly positively correlated (rs=-0.566, N=16, p<0.0005, two-tailed) (p = 0.022) with the level of maintenance. This points to the fact that the parks in the better-off areas tend to be in a better condition than those in the poorer areas.

The level of activity was also found to be significantly correlated (rs=0.745, N=16, p<0.0005, two-tailed) (p=0.001) with the level of maintenance. There is a negative correlation between the level of maintenance (rs=-0.600, N=16, p<0.0005, two-tailed) (p=0.014) and the evidence of anti-social activities. This suggests that good maintenance is important for reducing anti-social activities and also for enhancing the general level of activity taking place there.

The incidence of anti-social activity was also significantly correlated with integration R3 (rs=0.578, N=16, p<0.0005, two-tailed) (p=0.019) and with integration Rn (rs=0.693, N=16, p<0.0005, two-tailed) (p=0.003). This suggests that the parks situated in the most

integrated areas, being generally poorer and more accessible, also attract the wrong kinds of use. This may also be linked to the lack of maintenance, which was also associated with anti-social behaviour noted above.

DISCUSSION

The results of the city-wide analysis of parks and their distribution show a complex picture. There is clearly no consistency or clear pattern in the distribution of parks or other green areas in relation to the urban residential patterns. This is hardly surprising in a city where unplanned sprawl has been a major feature. Generally, it makes no particular difference if someone is living in a wealthy or poor district in terms of the availability of green space either on a per capita basis or within easy access. The results of this study do not generally correspond with Byrne et al, 2009 who found green space is often inequitably distributed, although locally it is more the case (see below). As Kaplan and Kaplan (1989) showed, individuals living in areas lacking green space may be more vulnerable to the negative impacts of stressful life events because they have fewer opportunities for nature-based coping strategies than individuals living in areas with abundant green space. In Tehran, therefore, social class may matter less than proximity to green areas as far as health is concerned.

If we only look at the total amounts of green spaces globally, then the picture is misleading, as much of the green space is accounted for by a few large forest parks out on the periphery which are not suitable for daily recreational use. As a result, we can say that there is no equitable distribution of parks at all – it is not that the better off have more green spaces than the poor; some both poor and wealthy districts have adequate amounts and some low amounts. However, since the wealthier inhabitants have more access to cars they are able to travel to the “destination” parks more easily. As Lotfi and Koohsari (2000) showed, poor households usually use the nearest facilities to avoid transport costs, while high income groups prefer to travel farther distances to stay away from crowded parks and other public spaces.

The results of the space syntax analysis proved to be interesting and showed that some parks were located in well-integrated street patterns. When this was correlated with the factors assessed for the sampled parks it tentatively appeared that those parks assessed on the ground as being accessible were also in more highly integrated areas and these tended to be in poorer socio-economic clusters, especially neighbourhoods in R3 and at the Rr level. This can be explained as a result of the characteristic of the street pattern. The most integrated parks in poor areas were also the least well-maintained. Thus the space syntax theory of Hillier et al (1993) works to a degree but in this case is not as revealing as we hoped it might be.

Turning to the sampled parks, we can see that those in poorer areas tend to be less-well maintained and show more signs of anti-social behaviour than those in better-off districts. Thus, although the city-wide picture of environmental equity is unclear, at the level of individual parks and their condition it is a fact. In addition, when looking at the population in the catchments for some of these parks, they have very high densities compared with the better-off locations. This fits better with the kind of evidence found by Byrne et al. and consistent with Kuo and Sullivan (2001) who observed poor housing, inadequate sanitation and high levels of crime being linked to a lack of green areas.

If we look more closely at some of the sampled parks, we can see specific characteristics emerging which are often apparently contradictory. For example, Shabnam, located in the west of Tehran (District 5), has the highest density surrounding population of a low socio-economic status among all the 16 sampled parks. It has low global integration and generally low levels of use and is in a poor condition. Thus a park which might be expected to be popular is not and needs action in order to improve things.

Azadegan Park has the second highest population in District 15, with low global integration but high local integration R3. This large park is on the edge of Tehran, in a low socio-economic, deprived district, and is in high demand for recreation by people living there. However, it is poorly maintained, possibly as a result of the huge levels of use overcoming the efforts of maintenance staff. This matches the findings of Lotfi and Koohsari (2009) who reported that limited accessibility to Tehran's local parks led to the over-use of existing parks, impacting their efficiency.

At the other end of the scale, Jamshidiyeh and Abo atash Parks are located in the highest socio-economic districts and the former is also the most popular park in Tehran, with a high level of use, often crowded but remaining in good condition. They are also in locations with low levels of integration from the space syntax analysis at all three radii (Rn, R3, Rr). Mellat park is also one of the top parks located in a high socio-economic level district but with low syntactical integration. Their popularity this can be explained by the fact that these are well-equipped parks linked to the urban motorway network and are destination parks rather than local parks.

Some parks are popular for specific reasons despite their otherwise negative qualities. For example, Daneshjoo is located in District 6, which is a deprived area with a low population density, evidence of high anti-social activity and in a poor condition. Nevertheless, this park is also busy and well-known because of a popular theatre also located there. It is one of the few parks with high values of integration at all thee radii(Rn-R3-Rr), so the accessibility is also good, which may also explain some of its popularity. This finding at least seems to be somewhat consistent with space syntax theory. Also, as Gregory (1986) pointed out, accessibility can measure the relative

opportunity for interaction or contact which is important for social values and this park bears this out.

Bagh Honar Park is also well-known because it has a popular art centre. The level of the use is high, with a wide range of activities. While located in a low socio-economic level district, most of the visitors are of a higher, well-educated social class, and the park has high global integration (Rn). This is therefore a destination park, easily accessible from around the city but not much used by the local people. It has the potential for social interaction identified by Michie and De Rozarieux (2001).

Compared with the cities in the west, where secondary data is freely available and use patterns, can be modelled fairly accurately, in cities like Tehran it Is not so easy to determine the broad patterns and to see any logic in park systems. This is simply because the data are not available to the same quality or resolved to the same scale. What this research has shown is that using available data together with some fairly simple fieldwork, GIS tools and basic statistics, it is possible to make a stab at understanding the broad pattern of the parks and green spaces (we cannot in fairness call it a system) of a city like Tehran.

CONCLUSIONS

The objective of the research was to obtain an overview of the distribution of green spaces in general, and parks of various types in particular, at the scale of the entire city and to examine their degree of accessibility, the demographic character of their catchment and their current usage. The specific research questions were:

1) How well are the green spaces distributed in relation to the urban structure and how does this affect their accessibility? The answer is that the parks are generally unevenly distributed across the city, some districts being well-endowed and others lacking in parks. The presence of large areas of forest park skews the figures for the overall amount of green space as these are neither conveniently located nor popular (they supply ecosystem services other than recreation very well, however). Some parks are more accessible due to their location in well-integrated street patterns according to the space syntax analysis, although this proved inconclusive in terms of predicting which would be the most popular for other reasons, such as the fact that some parks are destinations for people from all across the city.

2) Is there a relationship between the accessibility of the parks and their quality and level of use? There is a relationship here but it is not especially strong. Quality and level of use are more associated with the size of the park, its level of maintenance and absence of evidence of anti-social behaviour. Some parks with good accessibility are less-well used because of the latter factors.

3) How equitably is the quality of the parks distributed in relation to the socio-economic and demographic structure of the city? While the general availability of parks is unrelated to the socio-economic and demographic structure, there is a clear pattern of the best quality and best maintained parks being located in districts with higher socio-economic status. However, many of these are also destination parks and people from all over the city visit them so that it cannot be assumed that good parks are only used by better-off people.

Finally, we can observe that this study provides a good starting point for more in-depth evaluation of green spaces in Tehran and it raises important questions for future planning processes. More data is also needed if the same levels of association between green space, recreation, health and wellbeing are to be established as have been in western countries; and more awareness is needed of the environmental and cultural conditions which must surely play a part in Iran but which are invisible in the data we used.

This is one of the main messages from this research: in the context of fast-developing mega-cities worldwide, such as Mumbai, São Paulo, Istanbul or Lagos, where infrastructure of all kinds, but especially green infrastructure, fails to keep pace and where coordinated planning lags behind, major health and social problems can be exacerbated. Better data are needed and such cities can learn a lot from those countries with more advanced planning systems and more systematic data. The tools to analyse and understand the situation as a means of assisting better green space planning are available but they rely on good data.

BIBLIOGRAPHY

Andalib, A., 2007. Renovation notes for deteriorated urban areas Volume 1. Tehran City Revitalization Organization, Tehran.

Asgari, A., 2001. Urban land use planning. Nor Ghalam press, Tehran.

Azimi, N., 2004. Restructuring urban morphology in the context of a globalizing economy: A case study of Rasht, Iran. University of Guilan Research Report, University of Guilan, Rasht.

Bahrami, B. and Aiyanna, K.V., 2012. Urban ecological landscape of Tehran. University of Mysore, Mysore.

Bell, S., Alves, S., Silverinha de Oliveira, E. and Zuin, A., 2010. Migration and land use change in Europe: A review. Living Reviews of Landscape Research 4(2), 5-49.

Byrne, J., Wolch, J. and Zhang, J., 2009. Planning for environmental justice in an urban national park? Journal of Environmental Planning and Management 52(3),365–392.

Chiesura, A., 2004. The role of urban parks for the sustainable city. Landscape and urban planning 68(1), 129-138.

Crane, P. And Kinzig, A., 2005. Nature in the metropolis. Science 308, 1225–11225.

Department of Social and Cultural Studies, 2011. The typology (clustering) of neighbourhoods in Tehran. Municipality of Tehran, Tehran.

Escobedo, F. J., Kroeger, T. and Wagner, J. E., 2011. Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. Environmental Pollution 159(8), 2078–2087.

Gehl, J. and Gemzoe, L., 2001. New City Spaces. Danish Architectural Press, Copenhagen.

Golkar, K.,1998. Theories of urban design, typological analysis. Journal of Research in Architecture and Art 29

Grahn, P. and Stigsdotter, U.A., 2003. Landscape planning and stress. Urban Forestry & Urban Greening 2(1),1-18.

Gregory, D.,1986. Accessibility. In: The Dictionary of Human Geography, Johnston R. J., Gregory, D. and Stoddart, D.R. (Eds.), Second edition. Blackwell. Oxford

Groenewegen, P. P., Van den Berg, A.E., De Vries, S. and Verheij, R.A., 2006. Vitamin G: effects of green space on health, well-being and social safety. BMC Public Health 6:149.

Hami, A., Suhardi, B.M., Manohar, M. and Shahhosseini, H., 2011. Users' preferences of usability and sustainability of an old urban Park in Tabriz, Iran. Australian Journal of Basic Applied Sciences 5, 1899–2011.

Hartig, T., Mang, M. and Evans, G.W., 1991. Restorative effects of natural environment experiences. Environment and behaviour 23(1), 3-26.

Hekmati, G., 1994. Design of garden and parks. Farhang Jame Press, Tehran.

Hillier, B., Penn, A., Hanson, J., Grajewski, T. and Xu, J., 1993. Natural movement: or configuration and attraction in urban pedestrian movement. Environment and Planning B: planning and design 20(1), 29-66.

Jalili, A. and Khosravi, A., 2009. Research on strategies of green space development in Tehran Master plan. Pajohesh and Sazandegi, Natural Resources Journal, Tehran.

Jorgensen, A., Hitchmough, J. and Calvert, T., 2002. Woodland spaces and edges: their impact on perception of safety and preference. Landscape and Urban Planning 60, 135–150.

Kaplan, R. and Kaplan, S., 1989. The experience of nature: A psychological perspective. Cambridge University Press, Cambridge.

Kuo, F.E. and Sullivan, W.C., 2001. Environment and crime in the inner city: Does vegetation reduce crime? Environment and Behaviour 33(3), 343-367.

Lavin, T., Higgins, C., Metcalfe, O. and Jordan, A., 2006. Health impacts of the built environment. A review. Institute of Public Health in Ireland, Dublin.

Lindheim, R. and Syme, S.L., 1983. Environments, people, and health. Annual review of public health 4(1), 335-359.

Lotfi, S. and Koohsari, M.J., 2009. Measuring objective accessibility to neighbourhood facilities in the city (A case study: Zone 6 in Tehran, Iran). Cities 26(3), 133-140.

Madanipour, A., 1999. City profile: Tehran. Cities 16(1), 57-65.

Michie, C. and de Rozarieux, D., 2001. The health impacts of green spaces: a rapid review to support the Mayor of London's Biodiversity Strategy. Ealing Hospital NHS Trust, London.

Mohsen, F., 2006. The role of urban parks in a metropolitan city. Environmental Sciences 12, 29-34.

Moradi, A. Dabiri, S., Gharagozlou, R., Rahmati K., Shima, A. and Armin E., 2012. Understanding a new combination of technology and art in historic Abbas Abad Garden-Behshahr. Advances in Environmental Biology 6(4), 1357-1363

Nielsen, T. and Hansen, K., 2007. Do green areas affect health? Results from a Danish. survey on the use of green areas and health indicators. Health Place, Copenhagen.

Ormel, J., and Neeleman, J., 2000. Towards a dynamic stress-vulnerability model of depression: the role of neuroticism, life events and gender. In Harris, T. (Ed.) Where inner and outer worlds meet. Psychosocial research in the tradition of George W. Brown. Routledge, Abingdon

Pauleit, S., Breuste, J. and Qureshi, S., 2010. Transformation of rural–urban cultural landscapes in Europe: Integrating approaches from ecological, socio-economic and planning perspectives. Landscape Online 20, 1–10.

Peters, K., 2010. Being together in urban parks: Connecting public space, leisure, and diversity. Leisure Sciences, 32(5), 418-433.

Relf, P.D., 2008. Renewing the relationship between people and plants in the 21st Century. Proceedings of the VIIIth International People-Plant Symposium. Acta Hortus 790, 45-52.

Rostami, R., Lamit, H., Khoshnava, S.M., Rostami, R., Rosley, M.S.F., 2015. Sustainable cities and the contribution of historical urban green spaces: A case study of historical Persian gardens. Sustainability 7(10), 13290-13316.

Rosenberger, R.S., Bergerson, T.R. and Kline, J.D., 2009. Macro-linkages between health and outdoor recreation: The role of parks and recreation providers. Journal of Parks Recreation Administration 27, 8–20.

Statistical Centre of Iran, (2011). Public census of population and housing of Iran. The results of the city of Tehran. Tehran.

Tavahon, A., 2004. Urban planning and management. Municipality Journal 17.

Turner, A., 2010. Depthmap 4: A researcher's handbook. Bartlett School of Graduate Studies, University College London, London.

Tehran Municipality. 2007. Tehran Master Plan. Tehran

Ulrich, R.S., 1983. Aesthetic and affective response to natural environment. In Behaviour and the natural environment, 85-125. Springer, Berlin.

United Nations, Department of Economics. 2005. World Population Prospects: Sex and age distribution of the world population (Vol. 2). United Nations Publications.

Warren, D., 1981. Helping networks - how people cope with problems in the metropolitan community. University of Notre Dame Press, Notre Dame.

Wolf, K.L., 2010. Crime and fear - a literature Review. Green Cities: Good Health. College of the Environment, University of Washington, Seattle.

World Health Organization, 2000. Obesity: preventing and managing the global epidemic (No. 894). World Health Organization, Geneva.